The Ultimate Regenerative Receiver

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Part 1

Warning-This article contains material that may be irritating to experienced builders. Reader caution is advised

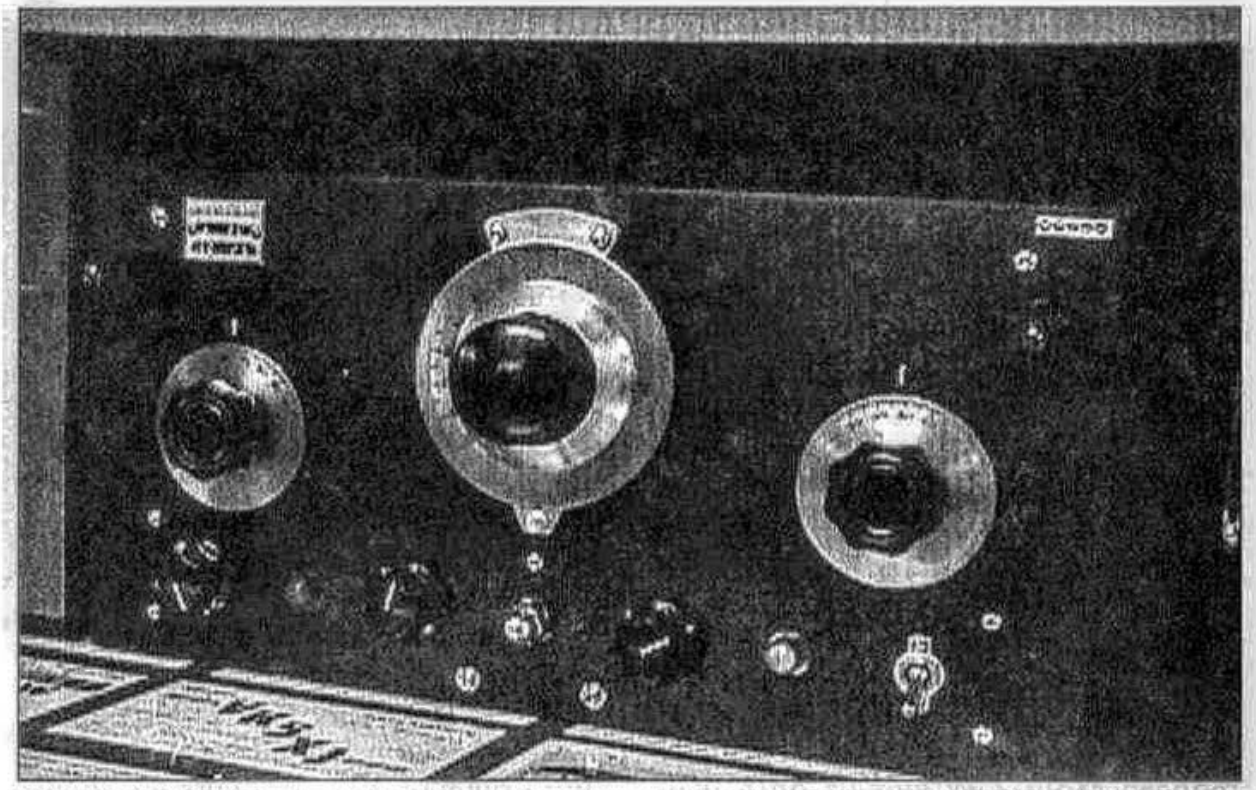
I call this radio my 'Ultimate Regenerative Receiver' because it is the best receiver I've built. I'm sure there are better 'regens' out there—perhaps many readers of this article have better—but as far as my home built receivers go, this one is the 'ultimate.' It's taken me long enough—59 previous attempts to be exact—but I've finally built one that exceeds my expectations. My intention is to fully explain the construction of my radio in such detail that even those who have never built a radio before can duplicate my results.

How good is the radio? It worked so well when I first powered it up that I simply did not believe it. In a side by side listening test between the 'regen' and my Drake R4-B, I copied more stations on the 'regen' on 20 meter CW, than I could copy on my Drake. Obviously, I reasoned, the Drake was defective. I then checked the Drake against my Corsair, it seemed to be working normally. Again, I tried the regenerative radio against my Drake R4-B with the same results. I knew it was impossible for a detector-amp regenerative radio to equal the results of a Drake, so I tried it against my Corsair II with amazing results. The Corsair had the edge here and there, but the operation of the sets was so close to equal that I began to doubt my sanity. "Surely, this is the early stages of senility," I thought.

Next, I tried the "Ultimate' against my old and trusted Kenwood TS-930. Unbelievable!

Now, totally frustrated, I wrote an e-mail to the Editor of ER, and to Dave Ishmael, WA6VVL, a writer for ER. Dave is an Engineer, and an accomplished radio builder. I explained my dilemma. In a side by side listening test, using the same antenna, the 'regen' held its own, and sometimes surpassed three very good commercial receivers. Please understand, I'm talking signal reception, not single signal reception. We all know 'regens' do not have a lot of modern goodies like AVC, crystal filters, digital readout, etc. My tests were basic—how many stations could I read on CW between 14,000 and 14,050. How did DX on the 'regen' compare to the same DX station received on my commercial receivers. I also ran a very subjective test—which receiver sounded more pleasing to the ear. No filters were used on the commercial sets. Sure, sometimes it was necessary to kick in the filter between my ears when listening to both the 'regen' and my commercial receivers. Tuning on the 'regen' is good and sharp, but as expected is less sharp than the superhets. Actually in my tests conducted in mid-afternoon, and later about 9:00 PM, the difference in sharpness was not a problem.

The results of my tests contradicted all logic, common sense, and past experience. The radio was working better than it should. Both Barry and Dave were kind, but somehow I have the feeling that they, like me, question the results of my tests.



This is the 60th regen that the author has built. He calls it his "Ultimate Regen".

I am presently building #61 & #62 as duplicates of #60 to assure that the results of this little receiver are repeatable. If you're reading this, then the two sets worked as expected.

Why have I built so many radios? Why have I concentrated all my efforts on old, obsolete, regenerative radio circuits? Why do all my sets look like something out of the 20' and 30's? Please allow me to explain.

When I retired I began building all the ham gear I longed to build when I was young, but could not do so because of a shortage of both time and money. At age 63 I found myself with a lot of time, and a large junk box of parts accumulated since the mid 30's. Let me explain. Five years later, I found myself with six home built KW rigs, several '100-watt class' transmitters, and a desk full of other assorted radios, antenna tuners, SWR bridges, audio filters, speakers, and accessories. As I searched for my next building project I read some articles on regenerative receivers that aroused my curiosity. In my youth I'd built 'regens,' sometimes called 'bloopers', but none of my early sets were good enough to encourage me to build more of the same.

Now, with forty years experience as a radio repairman, I finally built a regenerative receiver that showed promise. It hummed on twenty, squealed and whistled on forty, tuning was critical, and regeneration was rough. However, I was amazed at being able to listen to DX on a mere handful of parts thrown together in a few hours time. I began work immediately on another receiver using roughly the same circuit, correcting obvious faults found in the previous work. It worked better. I built a third, then a fourth. More often than not, my last radio seemed to work a little better than the previous set. If, after a reasonable time spent trouble shooting, the set did not work better than its predecessors, it was junked for parts. Perhaps if I kept building receivers, I would eventually get it right. I might even come up with a simple receiver good enough for serious ham communications. Before we go any further, if you are a SSB operator you

continued next page

may be wasting valuable time. While I listen to SSB all the time on my 'regens' I would not want to try to operate a SSB station using nothing but a homebrew regenerative radio—that would be an exercise in futility.

I readily admit I am partial—years of building simple receivers have made me 'soft' on regenerative receivers. I maintain that CW sounds better on a good detector-amp 'regen' than it does on most expensive modern day transceivers. Notice, I said 'sounds better.' No one would argue they are more selective, quieter, or that AVC, DSP, and digital readout are not a good thing, however in the hands of a skilled operator a simple 'regen' will give your new transceiver a run for the money, often pulling in stations better than the modern radio. CW signals on a well built regenerative have a unique sound-a quality I love and I'm sure you will too.

When I arise each morning I face northeast (toward Malden, Massachusetts) and bow three times. The National Radio Company serves as my inspiration. James Millen stuck with a simple three-tube radio that evolved into the SW-3. Take a look at the diagram of a National 1-10. I know of no radio circuit more basic. Yet, I've read that to duplicate the results of the 1-10 is very difficult. I am told that National Engineers, using the same basic circuit, built many different sets before they hit upon the proper mechanical arrangement that made the 1-10 work so very well. And we must mention the HRO, a classic from the day it was introduced. The HRO remained the 'flagship' of the National Company for over 25 years-and used plug-in coils long after band switching was standard on other manufacturers cheapest offerings. Millen's secret was in the mechanical construction more than in esoteric electrical circuits.

Numerous versions of the HRO, the NC-1-10, NC-100 and 101X, and others National sets I'm sure, used the famous PW dial. As a matter of fact, many builders today refer to the PW dial as the HRO dial. Take a PW dial apart—two moving parts, held together by two small coil springs. Few things are as simple-or more practical. Combined with a simple graph the PW dial enables accuracy in frequency readout very near to perfection. I use PW's on my homebuilt receivers when I can afford them. Introduced in the mid-30's the dial is unmatched today. It is simply the best. They are so valued by builders that they often fetch prices beyond my pocketbook. Only last week I saw one go for $85 on e-bay. It is not unusual for a PW to bring well over $100.

To better understand my obsession with regenerative receivers we should first take a look at the advantages, as well as the disadvantages of Edward Howard Armstrong's great invention. After all, it was the discovery of regeneration that made the vacuum tube a useful tool of communication.

Advantages of the regenerative receiver:

1. Its simplicity and ease of construction and 'regens' use very few parts.
2. Regenerative receivers offer excellent sensitivity.
3. Good audio quality when properly built and adjusted.

Disadvantages of the regenerative receiver:

1. Poor selectivity. Selectivity can be improved by adding an RF stage, but are the results worth the effort?
2. Temperamental tuning.
3. Hand capacity. Signal changes when we touch a control on the front panel..
4. Unstable—Signal drifts.
5. Signal 'pulls' as the detector tries to follow a strong signal as you tune across the band.
6. Microphonic detector. Tapping the table, or even playing the set loudly will often trigger 'feedback' or micro-

phonics.
7. Strong signals play havoc with reception. This is especially noticeable on contest weekends.
8. 'Dead Spots'
9. Need to adjust regeneration as you tune across the band.
10. Frequency readout is difficult.
11. Rough regeneration-squealing, howling, squawking, etc.

Is that all? Just eleven disadvantages? No, there are others but I have hit upon the main ones.

It appears obvious then that a 'regen's' disadvantages far outnumber its advantages.

Is it possible that some of the disadvantages of regenerative receivers can be partially or wholly eliminated by changes in our method of construction? The answer I believe is yes, it is quite possible. Mechanical construction is equally as important as the electrical circuits. I feel that the set featured in this article bears this out.

I have written several articles for ER describing my building efforts. If you recall most were general in nature and did not stress such things as precise component values-or even the circuits used. Receiver #60 is so good that I have decided to detail every phase of its construction.

This receiver, if built with any degree of care, will absolutely amaze you and it does it with a circuit so simple and easy to construct that you should easily complete it in less than 40 hours. And what can you expect for your efforts? You should end up with a receiver that pulls in DX with ease, and with ear shattering volume, has good frequency stability, (less than 1 KC for the first hour from a COLD start) readout accurate enough for serious ham radio operation. The receiver has regeneration that's unbelievably smooth, good sensitivity and selectivity is all one could expect from a regenerative receiver with no RF stage. On the Sweepstakes weekend recently I had no problem copying over fifty different stations on the CW portion of 20 meters with one pass up the band.

Before we get into the actual construction of this receiver let me explain a little of my philosophy of the regenerative radio. I have tried many different detectors, many different tubes, and many different circuits. In my opinion, adding a tuned RF stage to the simple detector results in better selectivity and perhaps more sensitivity. It also requires more parts, more shielding, more building expertise, more coil winding, more money, more time, and a helluva lot more chances for the receiver to operate at a level less than you expected. It can be the beginning of an exercise in hair pulling, nail biting, foot stomping frustration that only a tranquilizer the size of a vanilla wafer can curb. If we still lived in the age of Allied Radio when any needed part was available for immediate shipment, then my opinion might be far different. However, as you well know, parts are not easy to find today.

In a TRF receiver shielding is of the utmost importance and today you will have a difficult time buying off-the-shelf shielding materials. You better be skilled in metal work before getting involved with a TRF receiver.

Description of the Receiver

The receiver is built in two pieces. One piece contains the power supply, audio output circuit, speaker, and VR tube.

The second part contains the detector, two stages of audio amplification, and the frequency marker. Both units are built on identical size and weight chassis—10 X 14 X 3, .063 aluminum. They are available from K3IWK for around $20 each.

The circuit uses a 6C4 regenerative detector, 6SQ7 first audio, 6SQ7 second audio, 6V6 audio output, OD3 voltage

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regulator, and a 6SK7 marker oscillator. I am not a purist, I prefer solid-state rectifiers to tubes.

A few features of the radio are:

Shock mounted detector.

*Link coupled antenna.

Crystal marker for accurate calibration.

Precise adjustment of detector voltage.

Voltage regulation.

A two step attenuator in the antenna circuit for use on contest weekends.

Power supply and audio output on separate chassis from detector.

Pre-Construction Considerations

A word about coil forms. There are small manufacturers today who still supply plug-in coil forms. Most are of good quality. If you prefer to buy rather than build, manufactured forms will save you a little time. However, with my home built 'link antenna coupler' almost all available forms are a trifle short. I therefore prefer to 'roll my own.

For years I've been making my own forms from 1.25 inch PVC. I bought a 10 foot length of the tubing last week for 88 cents. I prefer coils a little taller than those offered by the trade today so I usually cut the PVC into 3.5 inch lengths. Lets see... If I cut the tubing into four inch lengths I'll get 30 forms for 88 cents. That is about 3 cents a form. Now I must add $1 per form for a base. If you have some old tubes you are home free. But even when I must buy a base I end up with $1.03 per base... Oh yes, I better add a dime to that for epoxy adhesive. Anyway, I end up with less than a buck and a quarter per form. Compare this with the five to eight dollars asked by sellers today...

"But," you say, "I'll never use thirty coil forms." Well, you may be right of course. However, if you only use six forms and throw the rest of the PVC away, you end up with a superior (In my opinion) coil form and save a whopping $30 to $40. That much money will buy you a nice, bright, new chassis from K3IWK, plus two or three tubes for your receiver.

Building today is not cheap. By carefully watching your money you can still build a receiver like the one in this article for about $250. If you have access to e-bay, a few local hamfests, and a well stocked junk box then the cost will be less.

I am often approached by someone wanting to buy one of my surplus 'regens'. Surplus homebuilt receivers are akin to surplus children. They are your creation and should, and do, mean more to you than anyone else. You may have too many kids, but which ones do you wish to dispose of. Secondly, I build my receivers 'stout' and spare little cost on parts. I think the proper term is 'overkill.' I dislike running any parts near their maximum rating. I also have a fondness for National PW dials and gear boxes for my tuning control. It is not unusual for me to end up with well over the $250 price mentioned earlier. If I priced a receiver for the exact amount I have in it there are many who would feel it was overpriced. If I calculate the actual cost of a receiver, and then charge my time out at $11 bucks an hour (this is what kids get today for stocking grocery store shelves) then I would have to ask somewhere between $500 and $700 for a simple regenerative receiver. Even this figure is conservative for some on my efforts.

So, like any hobby, building radios is not a way to save money, and certainly not a way to make money. It is a hobby, a most gratifying hobby, and nothing more. I can think of no hobby that delivers more pleasure for the dollar.

Let's discuss radio panels. Panels are a matter of choice, assuming they are sufficiently rigid. A piece of lightweight aluminum for the panel is in my opinion unacceptable. If you have access to some 1/8" aluminum stock, great! I am uncomfortable with anything less.

I have found that panels made from 3/16" plywood, backed with thin aluminum works very well. The same is

true for any of the hardboard stocks such as Masonite. Antique Electronics carry a black panel material that is similar to Bakelite in appearance. It is available in 8 x 24 inch sheets for about $14 per sheet. It takes two sheets to build this receiver. If you go this route, by the time you figure in packing and shipping charges, you are going to have well over $80 in the chassis and panels alone. This is why I opt for the plywood panels on most of my receivers. At home supply stores I can buy nice oak or birch plywood in 24 X 24 sheets for $4.45. A large sheet of thin aluminum stock suitable for shielding, and panel backing, will cost about $20 at the same store.

I finish my plywood panels a number of different ways—my favorite is to let the beauty of the wood come through. First sand the panel with very fine sandpaper. Then apply one or more coats of stain. I like to mix my own stains. I prefer a mixture of dark walnut and dark oak stain. This gives my oak panels a real 1920's look. This look can be enhanced enormously by the use of Mohawk Ultra Classic Toner. I use the 'Perfect Brown' color. This toner is easy to use and gives your panels a 'classic radio' look with gradual shading becoming much darker in the corners and along the outer edges of the panel. It is available from Antique Electronics.

Walnut and Birch plywood also look great when painted. I have finished panels in black, gray, and silver 'Hammartone.' If a painted panel suits you, you will save money. It is a lot cheaper to buy one can of black satin spray paint for four bucks than to buy stain, toner, clear varnish, and tack rags. Of course if you go for the stained panels you will have a lot of stuff left over to harden in the can before you toss it in the trash. Stained panels are reasonable in price only if you are doing several square feet of wood.

When you buy the plywood for the panels don't forget to pick up a 6 foot length of 1/2 inch aluminum strap. You will use over half of this making panel braces. It is of prime importance that you build a 'regen' rock solid. Why? The detector is tunable. Movement of anything in the detector circuit from the end of your long wire antenna tied to a tree in the backyard, to the grid of your first audio tube, will shift the frequency if it exhibits movement. Don't worry too much about the antenna movement, it is not as critical as some would have you believe. Do be concerned about anything on the detector chassis. A very slight movement of the panel will result in problems, including making CW signals sound 'chirpy'.

Radio construction can be divided into three parts—the mechanical construction, the circuit and wiring, and the cosmetics of the radio. Actually, a good radio builder pays attention to all three but you can save money on the cosmetics and end up with a radio every bit as good as one that costs you quite a lot more.

In future issues of ER I intend to explore all aspects of building this receiver. Our next installment will cover such things as the power supply unit, and layout the receiver chassis. Schematics and parts lists will also be included so that you may start gathering up all the necessary items to complete your receiver. ER

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Part 2

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Power Supply & Audio Output Stage

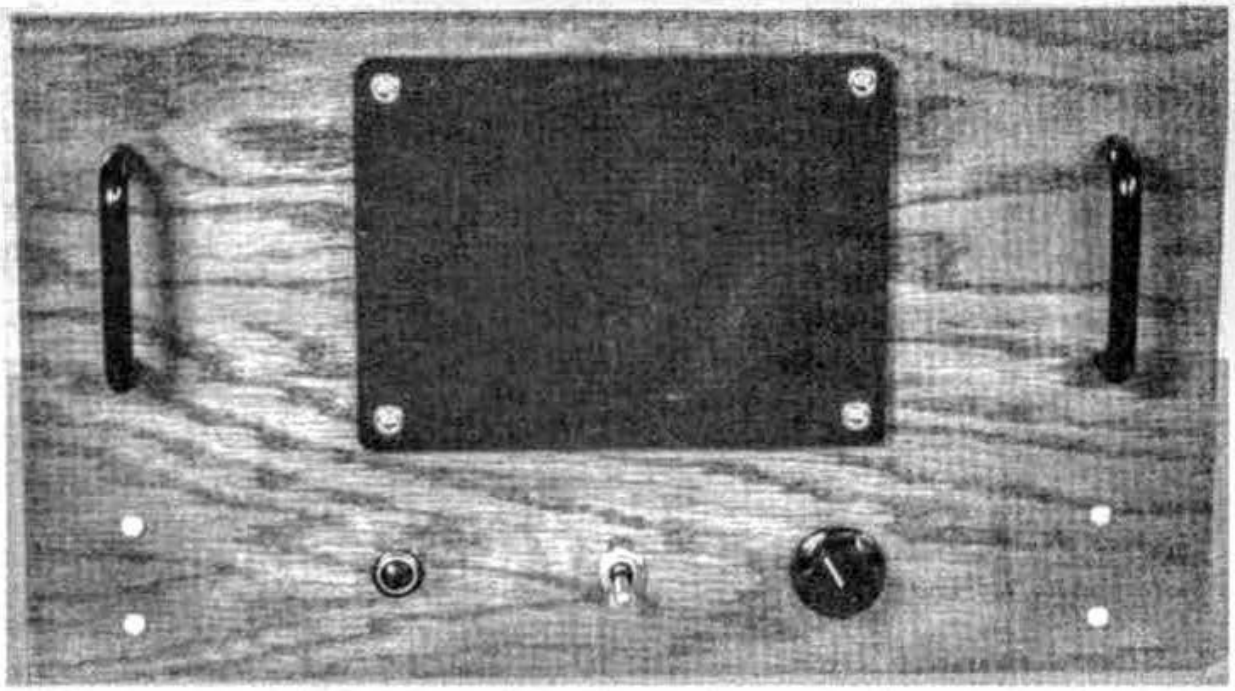
Why not build a receiver and power supply on one chassis? That's a good question. Many of my receivers are self contained, single chassis; receivers that have the power supply and speaker built as a single unit. Quite often such an arrangement works out well. However, as we all know there are certain advantages to building receivers with a separate power supply. This was the norm for manufacturers such as National Radio for many years.

Removing the power transformer, bleeder resistor, choke(s), large voltage dropping resistors, and rectifiers, from the proximity of the detector tube eliminates a lot of heat buildup, and also reduces the possibility of hum pickup. In my little 'Ultimate,' one source of heat in the radio was the audio output tube. Placing the 6V6 on the power supply chassis moves most heat generating components away from the detector. The detector tube operates with less than 16 volts on the plate, and the preamp tubes are allowed to loaf along at about 100 volts, thus generating very little heat. Therefore the detector should be quite stable. Measured frequency drift on receiver #60, the one that inspired this article, is low for a tube type receiver; less than 1 kc for the first hour of operation from a cold start. Some of my receivers are better, while others are not nearly as good.

In this article, Part Two, I will cover in detail the construction of the power supply and audio output chassis. When this chassis is complete it can be checked out and 'burned in' therefore eliminating a lot of trouble shooting when the radio chassis is completed in our third installment.

Building a radio is a lot like making a cake. You take certain parts, or ingredients, measure everything carefully, put the listed items together in a certain way, and the results are more or less predictable.

My Mother, God bless her, was never known as one of the areas better cooks. Born and raised in the early part of the twentieth century, money was always a factor in her household. Spices in her cabinet were limited to three or four of the most common such as sage, cloves, ginger, and allspice. She was notorious for requesting recipes from her friends, and then changing the recipe to something that in no way tasted like the original. If the recipe called for a cup of shredded coconut she might very well leave it out or substitute chopped peanuts. Soda was often substituted for baking powder, granulated sugar for powdered sugar, sweet milk for buttermilk, and vegetable shortening for butter. If a pie recipe called for three cups of sliced peaches she would leave out two cups and substitute starch as an extender. Remember those big, tall, tasty apply pies they used to put in bakery windows? My Mother's pies never looked like that. Her pies were about the thickness of a pancake, and the crust



Front view of power supply/amplifier. Initial cut with coping saw in speaker grill gets lost in printing. Black on black is difficult to reproduce. It actually looks very good. Black knob is the tone control.

was seldom brown—she did not like wasting time waiting for a pie crust to bake.

Once her masterpiece was removed from the oven she would sample it and say, "Everyone is always talking about what a good cook Marie is. I borrowed her recipe and I don't think it is anything to brag about."

My point is, change the receiver design any way you want. You may very well improve upon my ideas. However, please remember when you make a change you are no longer building the receiver under discussion—you are building a prototype whose quality of reception will remain unknown until you complete the set. Everything I mention from the chassis size and weight, to each individual component is the result of a lot of years experience building radio equipment. My way is certainly not the only way—it may not be the best way—but it is what works for me. If I could obtain the same results, and at the same time save weight, room, money, or time, I would certainly do so. The old timers were right—keep it simple—build it stout.

Before we get to the actual construction details I want to mention two more things I consider of prime importance. NEVER, let the thought enter your mind that you might fail—that somehow, upon completion, your receiver may not work. We are positive it is going to work—what we do not know is when, and how well.

My second suggestion is to always practice 'overkill.' Almost every time I depart from this idea I end up regretting it. For example I always use more diode capacity than necessary. Diodes are cheap, transformers are not. I once built a 100-watt transmitter, and was running my final bench test and 'burn-in.' Every thing seemed fine. I had left the transmitter on for over an hour with no apparent problems. I left the shop and went in the house to eat lunch. When I returned to the shop I found the transmitter had actually burned up. The transformer was gone. Hot tar was all over the chassis. Most of the fire had been confined to the power supply area,

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but with smoke and tar all over the entire chassis. I decided to strip the chassis clean, toss all damaged parts in the trash, and rebuild. If I had spent one dollar more I could have saved myself a lot of money and time.

In the schematic I show a conventional full wave rectifier configuration. The circuit is conventional in every respect. There is nothing new or innovative here at all. I normally use two diodes in series in each HV lead. The added cost is small and additional power rating is a comfort.

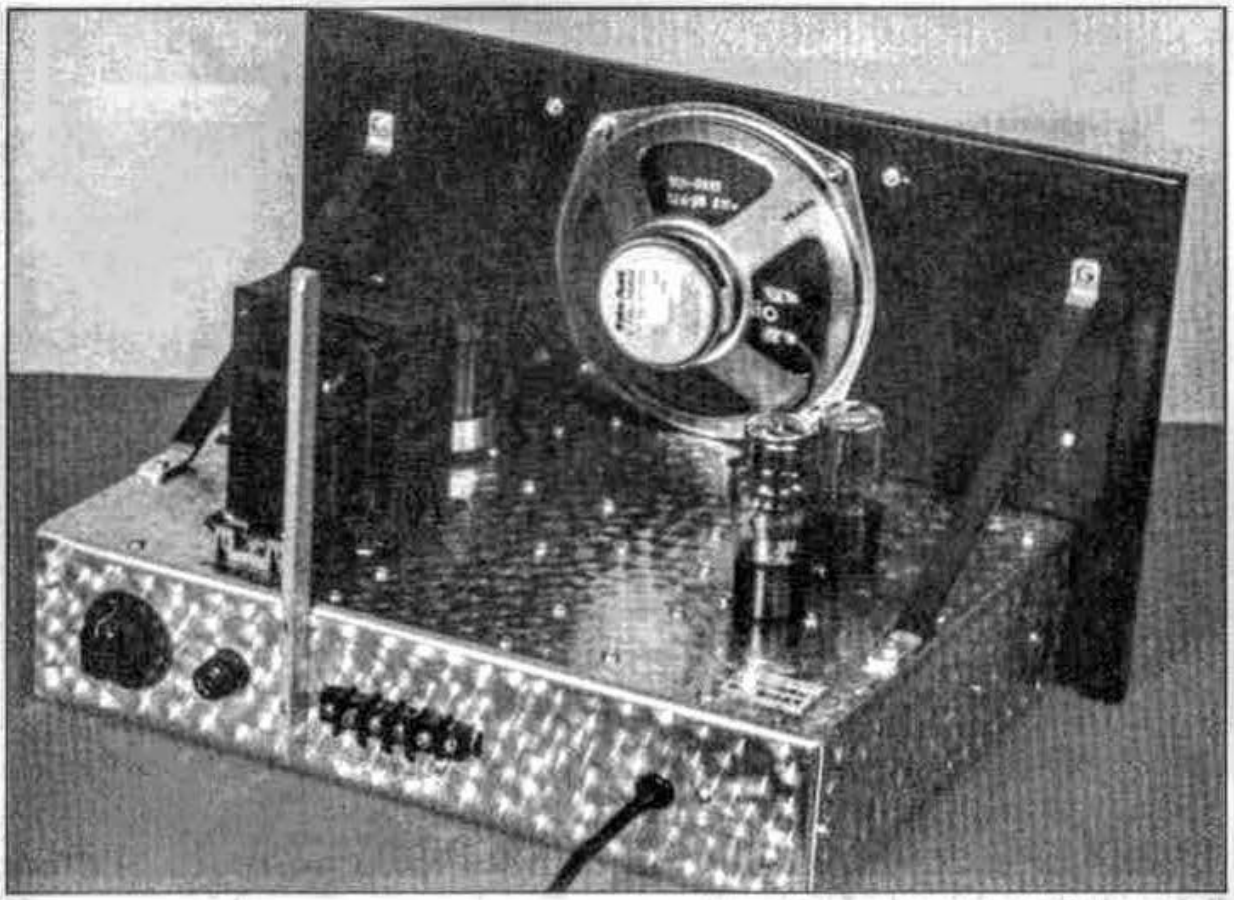
Let's begin construction. In 'Part One' I pretty well covered panel material. There is no need to back a nonmetal panel with shielding on the power supply/audio output chassis. Though different sized chassis pans may be used, you will have a much better looking finished product if you use matched chassis and panels. I prefer a chassis size of 10 X 14 X 3, and a panel size about 16 X 9—nothing critical—just make the panel large enough to accommodate your tuning dial arrangement. You can use lightweight chassis material, but the use of bracing and reinforcement under the chassis may be necessary to assure complete rigidity of all detector components, especially tuning capacitors. I have found it much easier and no more expensive to start with a .063 Byers chassis. If you buy one you will find they come cut and shaped but not drilled. They arrive in a flat pack; the top, two ends, and the two sides. All of my chassis' kits have been precisely cut and formed, and went together with no problems at all.

I have used at least a dozen chassis kits, and believe I have discovered an easy way to assemble them. First, lay out the four sides and the top. Inspect them for scratches. Mark the best long piece for the back of the chassis—the panel will cover up the front of the chassis. Now, inspect the chassis top for scratches. Mark the best side as your top. Use small scraps of masking tape and a pencil for all markings. Now, put the chassis together with a few pieces of masking tape. Duct tape is better if you have a roll available. Tape all four sides together, square with your combination square, then tape the top in place.

Three of the four corners will be fastened with two 6/32 X 3/8 machine screws, tooth washers, and a nut. To mark corners for drilling, adjust your combination square for 3/4 inch. Mark corners up from bottom and down from top. Then adjust the square and measure in from edges to a point that allows your screw to pass thru the center of the bent edges. Notice—on the front side, mark and drill holes the same on both ends. One end will be for attaching panel only—the screws are not needed to secure the chassis corner. On this corner only use one screw to secure corner and drill it midway between the top and bottom of the chassis end. This may be confusing now but once you tape the chassis together it will become quite clear. Attach top with screws about every three inches around the perimeter.

If you count the screws used in your assembly so far, you will find that you used about two-dozen screws on one chassis. To build the complete receiver you will probably use upward of 200 machine screws and nuts. As I mentioned earlier, find a wholesale nut and bolt supplier from which to buy your hardware. Last month I bought 400 outside tooth washers, 200 3/8 inch screws, 100 1/2 inch screws, and 200 nuts—all 6/32 size, from our wholesale supplier. My cost was a few cents over ten dollars. The same hardware from a well-known radio parts supplier would have cost me over $100. This is utterly ridiculous.

I find that using chassis kits is much more convenient than using a welded chassis. My little bench type drill press will not rise high enough to clear a 10



Completed power supply-audio amplifier unit. Control on the left rear of chassis is a 'hum bucker' used because my transformer did not have a center tapped filament winding. See text.

inch chassis. Using a welded chassis I have to resort to a hand drill and rattail file to drill large holes needed for fuse holders, AC line cords, SO-239 coax plugs, etc. With the chassis kit I just remove four screws and place the side or end under the drill press and use large bits or a hole saw.

I use two fuses in my power supply. More overkill. I place one fuse holder under the chassis with a 1.5-amp fuse in it. My other fuse holder is attached to the rear of the chassis and is easy to access. It has a 1-amp fuse in it. If everything operates as it should, the easy to replace fuse will 'blow' first. If something goes wrong, or someone places an oversize fuse in the rear holder, the unit is still protected by the harder to access 1.5- amp fuse.

Notice the big 'pot' on the rear of the chassis. This is a 'hum bucker' variable resistance. In this particular power supply, my power transformer does not have a center-tapped 6-volt winding. In a regenerative receiver this sets the stage for a nice bit of hum, especially on twenty meters. By placing a 30Ω-20-watt 'pot' across the 6-volt winding with the CT grounded, you have an adjustable 'hum-bucker.' I often use one even though the filament winding is center tapped. Remember we are using 1925 technology and twisting our filament supply leads. I've tried grounding one side of the filament and only using one lead—the way its been done for the past 60 years. I had to go back to the twisted filament leads to get really quiet operation. If you cannot find a 20-watt variable pot you may get by using a 10Ω-10 watt resistor from each filament lead to ground. Not ideal, but better than nothing. If you have a choice use a transformer that has a center tapped filament winding.

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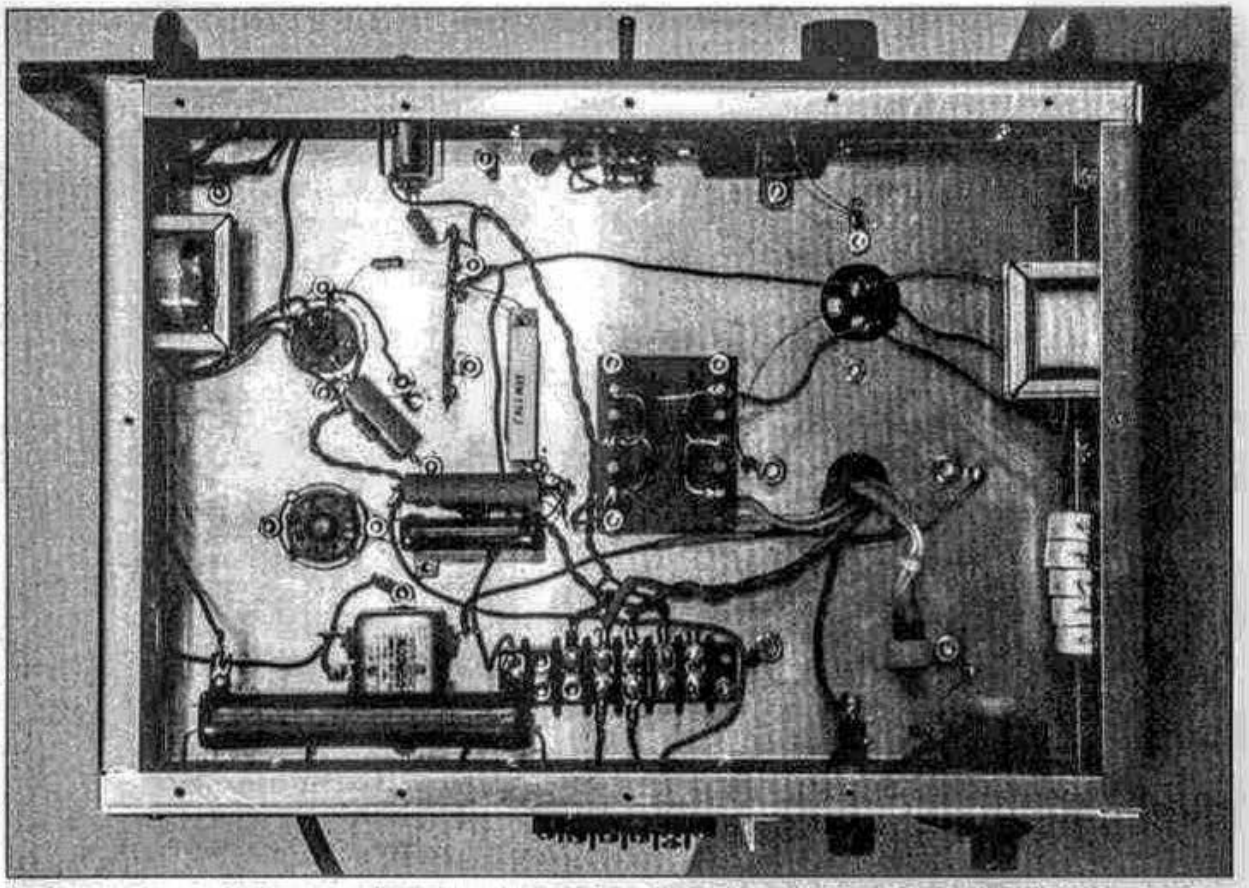

Below deck of the completed unit.

If your power transformer has a 5-volt winding use it for the pilot bulb. The old #47 pilot bulbs are too darn bright anyway. I always use a 10Ω to 15Ω resistor in my pilot bulb circuit to drop the voltage. It lowers the pilot intensity to a more comfortable level, reduces heat, and seems to make the bulbs run forever before burning out.

Let's talk about bleeders. A bleeder primarily serves two purposes; it discharges the filter capacitors quickly after the power supply is turned off, and it provides a constant load on the high voltage supply, thus tending to provide a limited amount of voltage regulation. If you go by the handbook, or by the advice of most writers, you will end up using a bleeder of 25KΩ to 35KΩ on a receiver power supply. I prefer one of a higher resistance. There are several reasons for my preference not the least of which is heat dissipation. The lower the resistance the hotter the resistor will become. As for discharging the capacitors, a 50/60KΩ resistance will discharge a capacitor within a very few seconds. You would have to be pretty agile to turn off a receiver, flip it on its back, and grab hold of a HV wire before a 60K bleeder does its job. As for the constant load/voltage regulation bit, the regulation offered is not all that great to begin with, and I normally use a VR tube for my detector-preamp stages anyway. I normally try a 50KΩ bleeder and if I feel the heat is excessive I add another 10KΩ-10 watt resistor. Even a 100KΩ bleeder will discharge the filters quickly enough.

You can make up a bleeder by wiring 5 or 6, 10KΩ-10 watt resistors in series. Mount them on whatever support you have available. I prefer terminal boards using tinned posts. I often make my own mounting boards from small squares of bakelite or a 'perf' board. If you have a nice big 30-watt bleeder in the junk box fine, use it.

You will notice that the front panel of

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the power supply has only a switch, a pilot light, and a knob for the tone control. The tone control is optional. Frankly, I've never been able to attain acceptable tone control with simple circuits. I look at the ones used by Hallicrafters, Hammarlund, etc., and most are pretty much alike—a linear pot, and a capacitor in series and connected to the plate of either the output tube or sometimes the plate of a preamp. I chose to install one in my #61 and it works moderately well. It is shown on the schematic.

One note here while it is on my mind. Very few pots today have enough of a threaded shaft to pass through a piece of heavy aluminum plus a 3/16" panel. The same is true of some toggle switches, and most all panel lamps housings. Here is the way I do it.

Attach the panel to the chassis with the nuts only moderately tight. Stretch a length of 3/4" masking tape horizontally across the front of the panel with the lower edge of the tape about 1-1/4" from the bottom. Set your combination square for 1.5" and scribe a horizontal line from panel edge to panel edge. Now set the square for about four inches.

Holding the square firmly against the bottom with the rule pointing vertically, mark the center of all needed holes for controls and pilot lamps. When marking with a pencil the mark will end up being about 1/16" from your square edge due to pencil point width. Once all holes are marked, center drill through the panel and chassis with a small drill bit—I find a 1/16" or 3/32" works well. Note which holes, if any, are for a control that has threads enough to pass thru the chassis and panel. Drill those holes before removing the panel from the chassis. You may find a switch with enough threads but chances are anything else will be too short. This means that for those controls you will need to cut a much larger hole in the panel. Use a 3/4 " hole saw and cut out holes in the panel for all other controls and pilots. Work slowly, do not force the saws or bits. When all panel holes are cut, sand with a fine sandpaper until smooth inside. Now, very carefully, paint the inside edges of all holes with a black felt tip marking pen. Drill appropriate sized holes through the chassis. The 3/4" holes in the panel will allow you to tighten nuts on the various controls, phone jacks, pilot bulbs, and switches. You may reinstall the panel at this point. Do not tighten screws excessively as complete removal of the panel may be required again. I wait until the receiver is working before giving all nuts a final tightening.

Output transformers are also on the scarce list. There are plenty available at greatly inflated prices but most of us are not that desperate—yet. With a 6V6 output tube you have a moderate amount of lee-way—our object is not necessarily high fidelity, but good crisp, clear short wave reception. Any transformer with a 5KΩ to 12KΩ primary and having a 4Ω to 8Ω output will do. I have been using Hammond transformers from Antique Electronics. They have a transformer available in limited supply for about $11 that works very well.

Perhaps my biggest problem in building power supplies is the available power transformers. I normally encounter higher output voltages than I need or want. Ideally, a transformer should have a secondary voltage rating of no more than 600VAC center-tapped. One with a 500 volt secondary would be even better. Unfortunately, almost any transformer you find will have a secondary high voltage winding that delivers nearer 800VAC. There are several reasons why this problem exists. Today, our normal house voltage runs about 120 volts. I just checked mine on my Weston model 433 line voltage monitor and it is a steady 119.5- volts.

continued on next page

When many of the transformers I use were built, the normal voltage was supposed to be 110-volts. I know from experience that it was often less. A transformer originally designed to have a 800-volt, center tapped, secondary winding when using 110 volts on the primary, would today have a higher secondary voltage. If my old K & E slide rule is telling the truth the voltage would be closer to 436 volts. Today, many of us prefer solid-state rectifiers—and for good reasons. So we have rectifiers with less voltage drop than the tube rectifiers in use when the transformer was manufactured. Then, because of the high prices of chokes, most builders today use capacitor input. Up goes the voltage again. In reality we may very well end up with a secondary voltage 75 volts to 100 volts more than the transformer delivered 50 years ago in a choke input, tube rectifier, half wave, 110 volt primary voltage power supply. I know of no easy way to lower this voltage other than through the use of high wattage resistors in the 'B' plus circuit. This is not the way to good voltage regulation hence the use of VR tubes.

Another consideration; a half-century ago most good home-brew power supplies used 8 mFd filter capacitors—often the capacity was less. The power supply shown in my diagram uses two 50 mFd., capacitors. Large capacity filters were a rarity when I opened my radio repair shop in 1946. The capacitor in the power supply pictured is a 50/50, 500 volt unit available from mail order houses today for about $12. That is pretty dog-gone reasonable considering the inflation rate—about $1 in 1946 dollars. So, with rectifiers delivering a smoother output, and with added filtration, we can get by with chokes that are less than the very best choice for clean output. Use the best choke you have, but don't sweat it. Most surplus chokes will take a lot more current than this set is going to draw.

One possible source of trouble: A VR-tube is made to furnish a constant voltage source. Of course it is necessary to feed the VR tube a voltage higher than its output. In the case of an OD3 the supply voltage needs to be around 170 volts. Check your handbook for the exact voltages for whatever VR tube you choose to use. There are formulas for calculating the various voltages and resistances. I prefer to do it the easy way and use the old cut and try method. The resistances in the schematic are what works well for me. However, your components may be far different from mine and you may find it necessary to experiment with R-13.

If your VR tube has insufficient voltage it will not regulate. If the voltage is too high, you may burn out the regulator. If it is on the borderline, you will notice the VR tube lighting with its blue glow and then going out. Normally if you feed a 150 volt VR tube 20 to 25 volts more than its rated output, you will be OK.

Next month we will conclude our article with construction of the detector-audio preamp unit. Some things you might be thinking about are your tuning capacitors and dial mechanism.

A 'so-called' midget 140 pF variable capacitor, the type made by the thousands back fifty years ago, make ideal band-set capacitors. They are not easy to find but are still available if you do a little looking. I see them weekly on e-bay-usually overpriced, but available. Expect to pay about 15 bucks for one. If you find it for less, consider yourself lucky. This capacitor can be installed without a vernier drive though I strongly advise that you do so only in desperation. I have built many receivers with direct tuning and they are very difficult to set on frequency.

As many of you know, I have an affinity for the National PW dial with its 180° gearbox. These dials command rather high prices. However, for some unknown reason PW dials have been

declining in price for the past year or so. It is now possible, though it may take patience, to find one for under $50. In years past I have watched in amazement as they sold in the $125 price range. If the PW is not available, or priced beyond your budget, other more affordable National vernier dials show up almost weekly on e-bay. A word of warning; all verniers are not created equal—some of the newer imported offerings are subject to slippage and are rather 'flimsy' in construction compared to National products.

Under no condition would I think of using a direct drive on the bandspread capacitor. This is in reality your main tuning capacitor and a vernier drive is a must. Use the best one you can find. The receiver will never be one bit better than the vernier tuning drive. A good tuning arrangement can make a mediocre receiver work like a real champion. ER

Letters from page 2

ARRL's "Interference From Transmitters" pp.B16-26 of Field Resources Directory 1986/87. It appears that transmatch manufacturers are using baluns with inadequate cross-sectional area to handle even moderate power levels of 375 watts of average power. Ask anyone who has attempted operating one of these marvels on 160 meters and you'll hear horror stories of overheating, shutdown, or destruction of the balun or transmatch unit.

The solution to the problems is apparent. If you are the unfortunate owner of one of these multi input impedance transmatches (as I am), you might want to experiment with core materials having a larger cross sectional area than your balun but with similar ratings and avoid the pitfalls noted above.

Better yet, home-brew a balanced tuner like KØOR.

David Olsen, W6PSS

Homebrew Transmitter from page 27

Conclusion

This has certainly been a challenging, frustrating and time consuming project. I have been working at it off and on again for about a year. There remains a couple of glitches to work out. The modulation transformer impedance is not exactly a proper match since I had originally planned to use 4-400's in the modulator. I am not satisfied with the amount of RF drive required to excite the final. These can be taken care of down the road. For now however, I have a beautiful transmitter that offers the satisfaction in knowing that it was built by my hands and in my workshop. It goes on the air easily and tunes up without any problems. I believe that building is one of the things that makes AM such a growing segment of the ham radio hobby. There was a time when hams built some of their equipment. Today's technology and lack of parts does not allow building state of the art sideband equipment. With a reasonable amount of skill, some luck in finding parts and hard work one can still create a homebrew AM transmitter that will give a sense of pride and accomplishment for years to come. By the way, to answer everyone's question about power levels these are the answers. The transmitter in Class C AM operation will unload down to 375 watts of carrier. For sideband linear service it will run the legal limit of 1500 watts peak envelope power. ER

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The Ultimate Regenerative Receiver

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Part 3, Conclusion

Warning-This article contains material that may be irritating to experienced builders. Reader caution is advised.

Last month we covered the Power Supply-Audio output unit for the 'Ultimate' receiver. Before someone reminds me that the old National Radio Company built some great regenerative receivers, I would like to stress again that this receiver is called the 'Ultimate' because it is the best one I've built. I am in competition with no one but myself.

Assuming you completed the power supply-amplifier chassis, I'm sure you gave it a long cook-in period on the bench to make sure it delivered a rock steady 150 VDC to the B+ terminal on the barrier strip mounted on the chassis rear apron. And I further assume that if you are an old timer you applied a wet finger to the grid of the 6V6 to see if the audio was working OK. If you applied a wet finger to pin three or four, I may be wasting my time giving further instructions. You could very well be operating from that great 'Ham Shack in the Sky.' Seriously, the safe and easy way to check the audio output stage is to clip a test lead to the grid of your output tube. A test lead will pick up AC hum found around any workbench. I leave my test lead connected while I am doing my preliminary 'meltdown' run-this allows me to proceed with other work. A sudden absence of humming from the speaker alerts me to yank the amplifier cord from the outlet. I am sure you had little trouble with this chassis so lets proceed to the final project.

My concern after first listening to the little receiver for a few days was that it seemed to be working better than it should. Did I just happen upon a configuration of NOS and junk box parts that worked perfectly together, or is there a reasonable explanation why it works so well? There's one sure way to find out-build a 'clone' and see if it also work's well.

Now, let's be realistic, today it is practically impossible to 'clone' a homebrew piece of radio gear. We can use the same circuit, try to adjust voltages close to the same, and even attempt to copy the parts layout-but because we use whatever parts we can find there is very little chance of the sets being identical.

Furthermore, as long as I was spending time (over 70 hours as it turned out) I wanted the same level of reception, but wanted to add a few 'improvements.' Because the set was a keeper, I decided to use my best PW dial and gearbox on it instead of the type 'N' dial used on the original. I also wanted to add a few more goodies-like a headphone jack, a standby switch, and a two- step attenuator. I do not believe any of these additions or changes should degrade or improve reception on the radio.

Well, I went ahead and built the receiver with the wanted changes. I used a different dial drive, a slightly modified parts layout, the variable antenna winding, 6C4 detector with 14 volts on the plate, and a shock mounted detector tube. It works every bit as well as the original. So, the results are apparently repeatable.

Bruce Vaughan with the latest version of the 'Ultimate' regenerative radio receiver. Little set under Bruce's elbow is Regenerative Receiver #1. The two-piece 'Ultimate' (receiver and power supply is regenerative #62.

My mail has been exceptionally heavy concerning this radio indicating high reader interest. It appears quite a number of readers actually intend to build the receiver. A number of readers have asked questions that are relevant, and should be addressed here before proceeding. If one reader has an intelligent question, then it follows that other readers probably have the same concern. I shall try to answer the questions as best I can.

1.... You use PVC coil forms. PVC has been proven to have more RF loss than other insulators. Why do you not use a lower loss material?

A... A few years ago I was lucky enough to buy three-dozen B&W air wound inductors. I have tried air wound coils on every frequency from 10 meters down to 40 meters. I can detect no difference in receiver gain. I am sure that with laboratory test equipment I could measure a difference but in actual listening tests I cannot. I might mention that I have experimented with lo-loss ceramic tube and coil sockets. Again I cannot hear any improvement when using them. One other consideration-in the receiver under discussion, the antenna coil is air wound with number 12 wire. There is only one winding on the coil form. That is one reason I love this receiver-the coils are so easy to wind.

2.... Why use, or recommend plywood panels?

A... If I could order the good, old fashioned, crackle finish aluminum, steel, or composition Bud panels for a reasonable price, I'd never cut a piece of plywood again. I am not in love with plywood. Frankly, I prefer the imitation 'Bakelite' panels available from Antique Radio-but they are only 8" high. This is shy about one inch for my use. Also there is the matter of cost. I do not 'penny pinch' when building, but neither can I afford a 'Damn the costs, full speed ahead' attitude. If you have aluminum panels custom cut you have two big problems-where can you get 1/8' stock cut to size, and how can you put a durable finish on the aluminum.

3... I want to use the receiver for High Fidelity radio reception. How well does it work on the BC band? Or a closely related question-I want to use the receiver on 160 meters. How will it work there?

continued next page

A... Regenerative receivers are great for CW. They work on SSB if you have a world of patience, and have great fidelity on foreign BC stations. However, you have a BIG problem when you try to make a regen that covers everything from the BC band up through ten meters. In the old days they even tried plug-in capacitors, as well as plug-in coils. The problems involved were too much for the idea to be practical. My regens work on 80 meters by forgetting about your main tuning dial and tuning in stations with the band-set capacitor. I consider this a real pain in the rear. If I wanted to work 80 meters I'd consider a receiver built for that frequency. I'd do the same with 160 meters or the BC band. Also, when listening to AM your throttle capacitor must be backed off to just below the point of regeneration. This means less gain. In reality, I would recommend a receiver employing one RF stage if AM was my primary interest. The 'Ultimate' works fine of 40 meter CW, though it tunes somewhat 'broad,' it really begins to 'shine' on 30 meters, is great on 20 meters, very good on 17 meters, passable on 15 meters, and practically useless on anything above.

4... Do you really need to build receivers this large and heavy?

A...Yes. If I want them to work, feel, and look the way I like receivers to do.

This is not to say that small, lightweight receivers will not work as well. I do admit that I have never built a small receiver that I considered a 'keeper.'

5... Why don't you build everything on one chassis? It seems you are doing a lot of work for a simple little regenerative receiver.

A... You are absolutely correct about the extra work, and it does cost more to do it this way. However, let's look at the advantages of my construction. One power supply and audio output tube can be used with any number of receivers you might wish to build, thus saving a hunk of money. Prominent handbook writers used to warn builders that it was almost impossible to construct a receiver using a Hartley detector circuit without picking up induced hum-especially on 20 meters. Hum has not reared its ugly head on either of my 'Ultimate' receivers. I have covered other advantages in previous articles.

6... I have read all your stuff and I still am not sure what kind of variable capacitors to use, or where to find them.

A... I understand the problem. I'll try and offer a simple explanation in less than 500 words-if I can. As to the desired capacity: For operation on 15, 17, 20, 30 and 40 meters I recommend the following. The Band-spread capacitor, which is in reality your main tuning capacitor, should be a two- plate capacitor with a spacing equal to about 30 pages of Electric Radio magazine. I have no precision calipers or measuring devices-sorry. As far as minimum capacity-the less the better but in reality if you can end up with a minimum of 10 to 12 pF you are in great shape. The maximum capacity should be about 20 pF.

For the 'throttle' or regeneration capacitor, a 100 to 140-pF midget is great. For the band-set or so-called main tuning capacitor, I prefer the old reliable 140-pF midget. Remember, this capacitor is where you set the band edge. The two-plate capacitor is the one that actually tunes in the stations so it is connected to your good vernier dial.

When building, set your two-plate capacitor slightly open-say about 10°, and connect it to the vernier drive with the scale reading zero. Why? Because strange things start to happen when a capacitor is fully closed. You might never have this problem but I darn sure have. In use, set your bandspread (main tuning) dial on zero, and adjust the band-set capacitor to the lower edge of

the band, 14,000 MHz for example. Then zero on the dial will = 14,000. Now, zero beat your regen with your transceiver set at 14,100. Note the dial reading of your regen. If it is on or near 50 for example, you will know that each division on your vernier is equal to 2Khz.

Let me inject a word about 'band spread' tuning. If you are following my advice in building you will find that the CW portion of 20 meters, covers about 1/2 of your tuning range. If you are using a 7:1 vernier this should be fine-but what about readout? As many of my readers know I am really fond of the National PW dial and gearbox as a means of tuning regens. I love the feel, the ease, and the accuracy of tuning in a station.

On a slide rule type dial of average size-say 8" overall width-the dial scale would be approximately 6 inches wide. On such a dial the band from 14,000 MHz to 14100 MHz would cover about 3 inches of dial scale. Buy a really BIG slide rule dial and you may cover 4 inches on the scale. How long would a slide rule dial have to be to equal the national PW dial? On my latest 'Ultimate' I measured the distance yesterday. It takes five complete revolutions of the dial to cover 100 Mhz on the PW dial. The circumference of the PW dial is approximately 14 1/2". So 5 X 14.5 = 72.5" or about 6 feet. You would need a slide rule dial about 12 feet wide to equal the readout accuracy of the PW.

As I reread mail I have received on this project it becomes quite clear that while most writers have a good understanding of radio, some come up trifle short in actual construction knowledge. There is a small book available I highly recommend to anyone interested in building regenerative radios. I refer to the book by C.F. Rocky, "Secrets of Homebuilt Regenerative Receivers," printed by Lindsay Publications, Inc. I urge you to read, and believe the ideas put forth in this small book.

I think we have more than covered questions people have asked me via e-mail. Let's get back to work.

I began construction by cutting two panels, 9 X 16 from 3/16" oak veneer. I found out, much to my regret, that 3/16 plywood is rather fragile-it's easy to break if you accidentally strike a corner against a hard surface. A piece of screen molding glued to the backside-along the top and both sides should do much to strengthen the thin plywood. I marked the 45° corners of the trim using my combination square, and sawed them with a hacksaw. Surprisingly, the corners looked very good.

Next, I attached a piece of aluminum to the back of the detector panel with JB weld cement. This shield need not reach the bottom of the chassis. Make sure it reaches down to the chassis top and then ground it to the chassis in at least two places.

After sanding, the backs of the panels were painted satin black, and the front finished with stain, followed by three coats of Minwax(r) polyurethane wood finish, then a coat of paste wax. My favorite wax for wood is Kiwi shoe polish-neutral color.

Actually, the power supply, detector chassis, panels, and braces were all completed before I began wiring the power supply.

Speaking of panel braces brings up another thought. For years after WW II, surplus equipment handles were available for practically the taking. Recently the supply seems to have disappeared. I find that drawer pulls from Home Depot, or Lowe's home supply stores work just as well. Drawer pulls, which cannot be told from equipment handles, are available in brushed aluminum, glossy black, brass, and chrome. Black drawer pulls are also available in plastic as well as metal. I

continued next page

buy the black pulls for about $1.00 each. Brass and chrome will cost more. The most secure and comfortable carrying handle for a radio is the chassis to panel brace. Never trust one of the plastic drawer pulls. While they are tough and have never broken on one of my sets, I do not wish to take the chance.

I recommend you install the pulls at the same time you install your chassis to panel braces. The top screw for your equipment handle can also secure your panel brace. Such handles on your receiver offers convenience when moving the equipment, but more importantly, they protect your panel, knobs, and controls when you need to turn the receiver face down on the workbench. This is their real value to me.

I tried to keep a loose record of time spent on my project. I can tell you without question that by far the most time consuming part of building is mounting the parts. In a previous article I underestimated my time to mount parts. It actually took me less than six hours to wire up the detector/preamp stage.

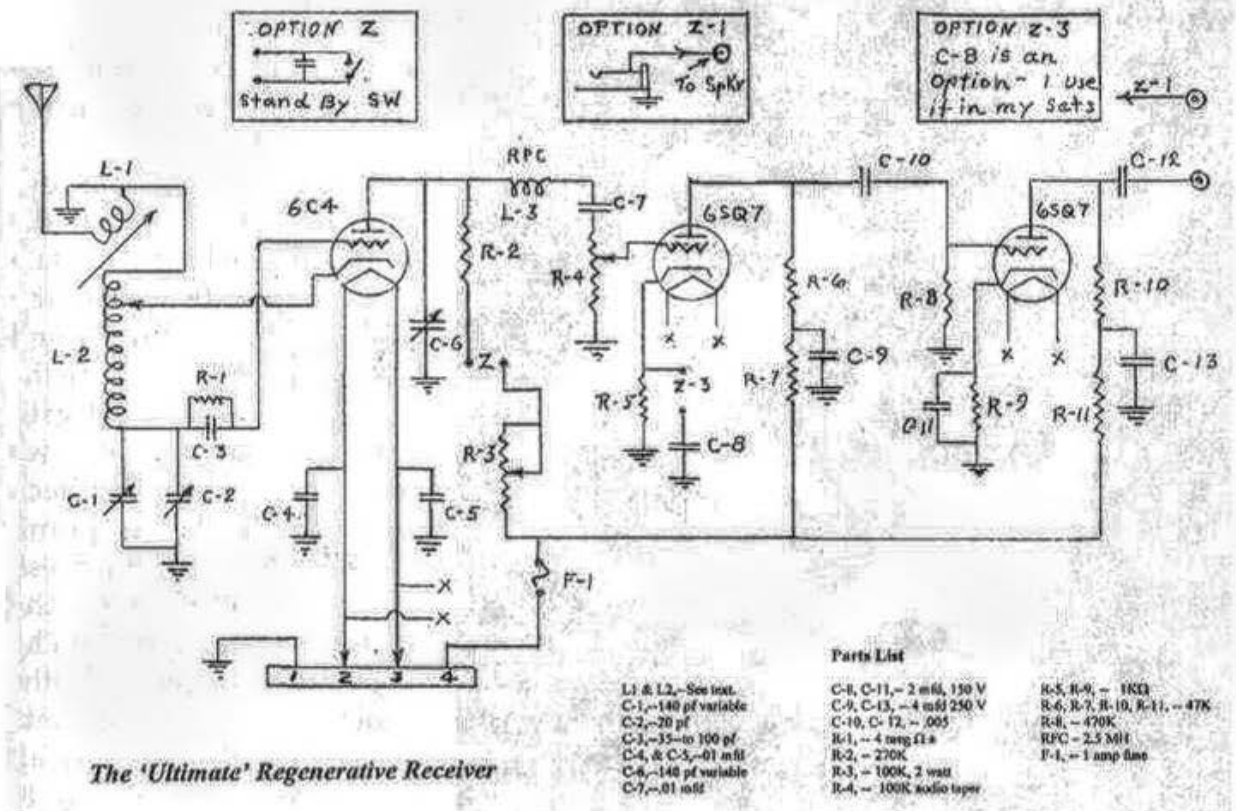
Notice that the power supply chassis, and the detector chassis, have 4-terminal barrier strips centrally located on the rear chassis apron. One terminal is ground, one is B+, and two are for the 6.3 VAC filament supply. Make up a 3-foot long; four wire cable with spade lugs on each end for connecting the two chassis together. Use one red, two green, and one black wire for your cable. As an added safety precaution, use a black and red felt tip marking pencil and mark the ground side of the barrier strip with black and the B+ side with red. I connect my filament leads to terminals 2 and 3. Simple, idiotic instructions, but we can all make mistakes. If we eliminate chances for errors while building we will have a more hassle free life later on.

Use a single wire, shielded audio cable to connect the audio out on the receiver chassis to the audio-in on the Power supply chassis. Standard female RCA jacks are used for audio in and audio out. If you choose to install a headphone jack, and choose to install it on the detector panel, you will need a dual wire audio cable to connect the jack to the speaker. I mounted my phone in, and phone out, RCA jacks about 1" from the audio in and audio out jacks.

Now is a good time to drink a cup of coffee and reflect upon the circuits involved. It will make your job much easier if you 'divide' your construction into stages. The receiver chassis consists of a simple Hartley detector circuit, and two triode tubes in a resistance coupled amplifier circuit. The marker generator is a convenience, but has absolutely nothing to do with operation of the receiver. It is a simple crystal oscillator using a 100 KHz or a 1000 KHz crystal. The lower end of most HF amateur bands can be determined by a harmonic of the crystal oscillator. Notable exceptions are 30-meters and 17-meters.

The marker being an option, perhaps we should discuss it first. The diagram for the marker is from an old ARRL handbook. Sorry, it is no longer in my possession. It seems to work well with my lower supply voltage of 150 VDC. I leave the filament hot along with all the other tubes and break the HV lead to turn it on and off. A 12" lead from the output coupling capacitor, run around the chassis near the detector-within an inch or so, seems to offer enough pickup. I avoid direct connections to the antenna or detector. If the signal from the marker is weak, wrap three or four turns of your lead around the antenna input.

Before mounting parts you have some decisions to make. Do you intend to do a marker generator at this time, later, or do you prefer to omit it altogether? If you intend to install it now, do you want a pilot light to tell you it is turned on? Do you want a standby switch? What about a headphone jack? Do you want some method of attenuating strong



The 'Ultimate' Regenerative Receiver

signals? All of these things must be determined before you begin mounting parts. All of these things mentioned require holes or other metal work, and should be considered so that the panel will present a balanced look. Not absolutely necessary, but it will certainly contribute much to the overall appearance-and performance.

It is better to mount such things as a headphone jack, standby switch, etc., and leave then disconnected if there is a chance you will want them later on. Switches, jacks, pilot light assemblies, are all available from Radio Shack at reasonable prices. You will invest less than ten bucks if you install three or four items that you never use. It is a real mess to try and add them after your construction is complete. Even if I were relatively sure I would never complete the marker oscillator, I think it wise to install octal sockets for the tube and crystal now.

If you are a novice at 'point to point' wiring a few tips might make your job easier. If possible, use tube sockets with ground lugs built into the base. If not, buy a handful of ground lugs and install one on each side of the tube socket. Some you may not use but it is far better to have one and not need it than to need one and not have it. Install terminal strips near the detector, the audio tubes, and the crystal marker. You may need more but you are sure to need them. Install a ground lug near the volume control, and near the coil base. It is surprising how many ground points you need.

BTW, for whatever it's worth, I checked my 'Ultimate' and find that while the C coil covers the 15, 17, and 20 meter ham bands, I recommend winding three coils to cover everything from 21 MHz down through 6 MHz. See coil table attached.

The A coil covers from 6 Mhz up through 10 Mhz, the B coil to cover 12 Mhz up through 21 Mhz, and the C coil will tune from 12 MHz up through 22 MHz. As expected, and desired, there is some overlap. I prefer coils that do not place my band of operation on either

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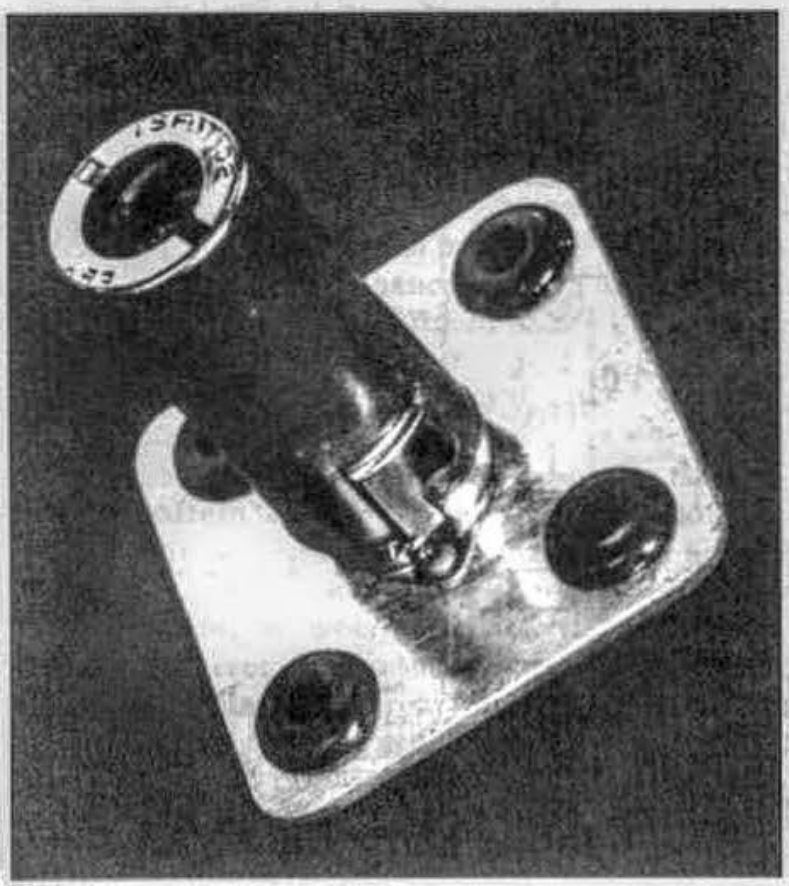


A closeup photo of shock mount for the 6C4 tube. Though the set will operate without the shock mount, it is good insurance against microphonics.

the upper, or lower, limit of my tuning capacitor. I would not expect my 80-meter coil to cover any additional bands.

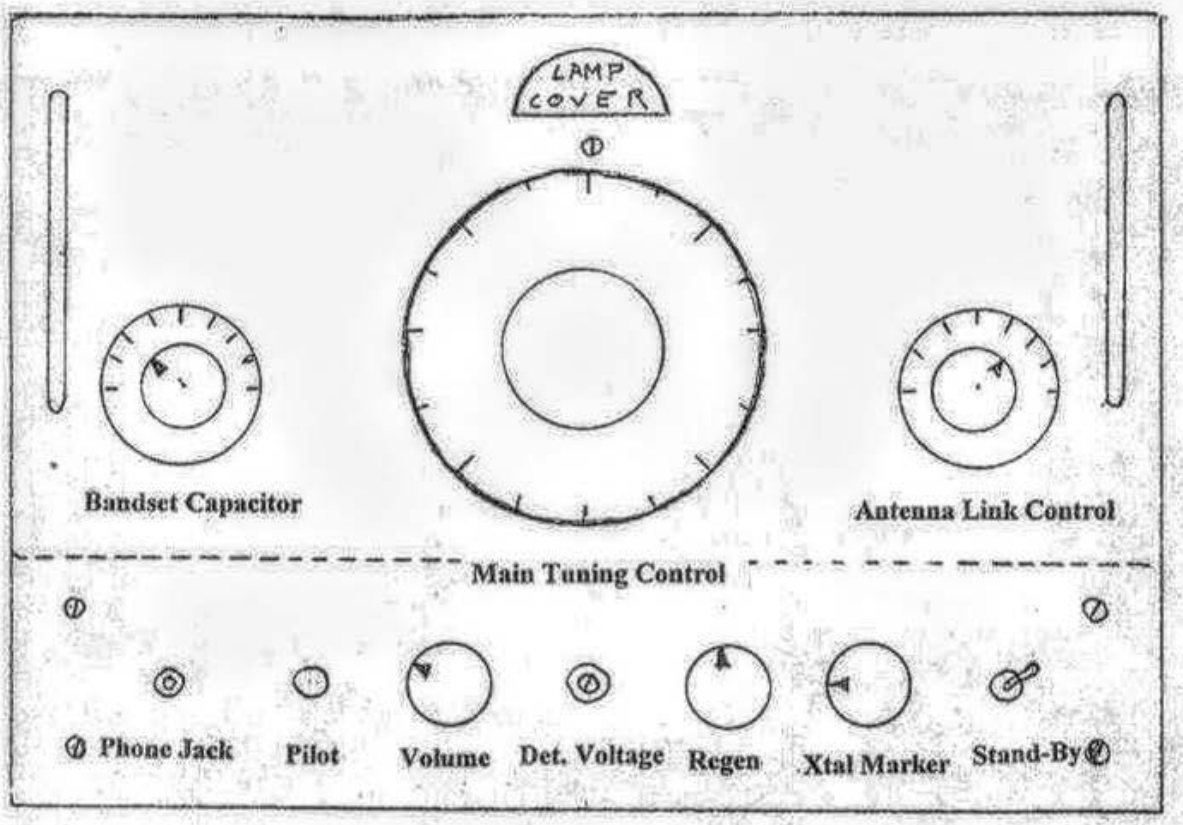
Back to the project, I like to wire up the two audio stages first. Go ahead, connect the power supply and check out the audio. If it works you are over 90% home free. The Hartley detector has only 8 or 9 components in it. When finished, if the set does not operate the way it should you have already eliminated the power supply and all audio components as a problem. All that remains is a very simple trouble-shooting job of the detector.

It is difficult to make an error in wiring of the two 6SQ7's. Do all filament leads first. Remember this is an old fashioned regenerative, twist your filament leads. Then solder all internal tube shields to ground. In the two 6SQ7s, the 6V6, and the 6SK7, this means solder pin one to ground. Now, install the proper resistances and capacitances from the cathode to ground on the preamp tubes.

Next, install the de-coupling resistors to the plates of each 6SQ7. Plate voltage readings on the 6SQ7's should be around 100 volts. Now install the coupling caps and grid resistor. That was easy...we can either double check everything at this point, give the audio another test, or can move on to the detector circuit. The capacitor, connected to the junction of the two plate resistors is not critical. Anything from 4 mFd to 16 mfd seems to work fine.

I am sure many of you recognize this as being the same audio circuit I've used in other receivers. I have used this same circuit, with very few changes, for many years. I believe in the axiom, "If it ain't broke, don't fix it." This audio circuit with its two 6SQ7's into a single 6V6 is very nearly fool proof. It has excellent audio-as most good resistance coupled circuits do-it exhibits no bad habits. The audio is more than adequate for a receiver-approximately twice the amount that most transceivers have. The circuit is very forgiving. Though I do not recommend it, values of components can be changed a lot and you will still have a good audio system. What more could you want? Low cost, that's what, and this circuit is right up there with the best when it comes to economy. I'll probably still be using this audio circuit when I become a silent key.

Confession time! When I completed my 'clone' of the 'Ultimate' I plugged it in and it worked-very poorly. I could not get the regeneration control, (throttle capacitor) to take the set out of regeneration. The detector was oscillat-



Front panel layout.

ing all the time. As a matter of fact, the throttle capacitor had very little effect on the thing. In a case like this my advice is to pull the big switch, pour yourself a cup of coffee, or a stronger beverage if that is your choice, and relax in your easy chair. Be in no hurry to return to the workbench. Stop and reflect. I did not realize I was even thinking of the receiver when suddenly it occurred to me that the trouble could only be one place-the coil. I had made some sort of stupid error while winding the coil. And I had. I simply soldered a lead from my grid coil to the wrong pin. When I corrected my error, the set really came alive-but the regeneration was still a little 'sudden.' By guessimate I had tapped my coil at 1 7/8 turns. The 6C4 goes into regeneration so easily that I reduced the tap to 1 1/2 turns and it is near perfect now. Not much of a change-but enough to make a big difference.

All variable capacitors in the set have grounded stators. Another great move toward simplicity. I use insulated, flexible shaft couplers when I have them. However, as the stators are at ground potential insulated couplers are not a necessity.

Mount the main tuning capacitor first. Mount your detector tube about 1 1/2" behind the tuning capacitor. Now mount your coil. With the loop of the antenna link lowered around the coil, mark the holes for the link assembly. It is necessary that the loop pass over the coil top without dragging on the coil winding. If you are fortunate you may find a throttle capacitor and band set capacitor that can be mounted directly to the chassis. However, this is the exception. You will probably need to bend some brackets from strap aluminum to mount these two caps. Be sure to use the combination square to mark your strap aluminum before making a 90° bend.

One bit of good news: you will probably not have to bend aluminum for shielding. By moving the power supply-audio output circuit to a sepa-

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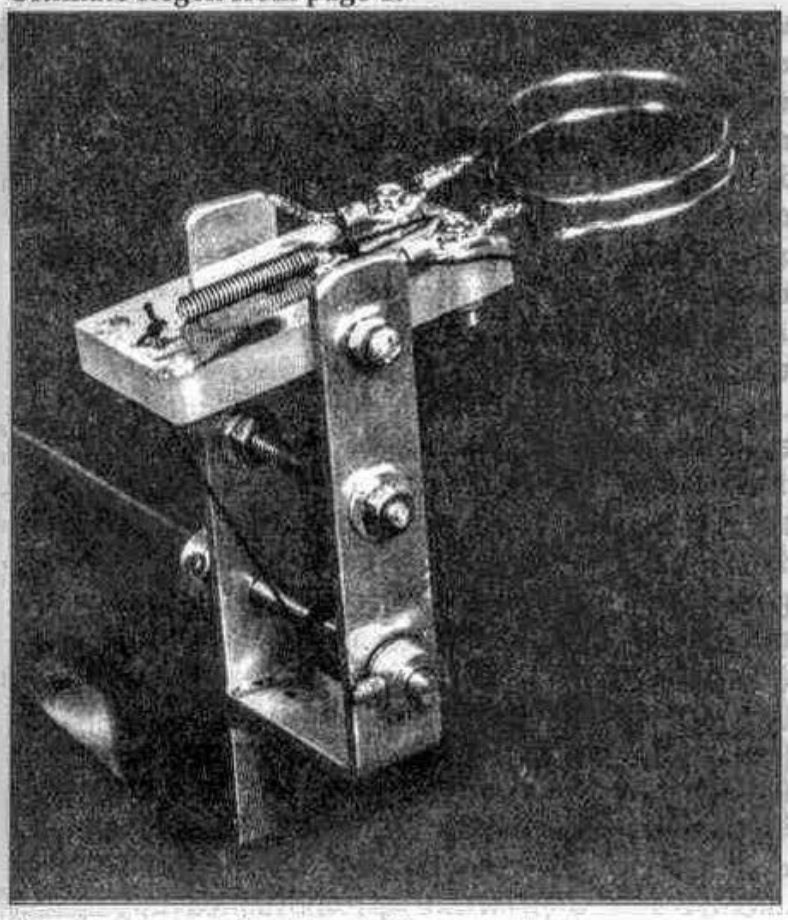

A closeup of the antenna link assembly.

rate chassis we eliminate the need for shielding of components in the detector circuit-in most cases.

What about panel bushings? They are very hard to find so if you choose to use them you will probably have to improvise. Old volume controls offer one source. The big problem is finding one with enough threads. Only older controls will have sufficient thread length to pass thru a thick panel. An easy, although less desirable source is your 'Home Supply' stores. They sell lamp repair kits with nuts, washers, and several inches of threaded brass (all-thread) sleeve. We have a minor problem with the all-thread in the lamp repair kit. The brass sleeve inside diameter is a little more than the 1/4" needed. If the shaft fits a little too loosely slip a short piece of shrink-wrap over the shaft where it passes thru the sleeve. Heat the shaft with your soldering iron and when the sleeve shrinks it should make a smooth fit. One other fix: clean the shaft well, coat with paste, then using a torch or large iron flow a coat of solder over the shaft section that passes through the bearing. When cool, chuck the shaft into your drill press and with fine emery paper, dress down to fit. Of course this is not a very good idea on shafts that will get a lot of use-tuning shafts for example. However, on such shafts as the band-set, throttle capacitor, or volume control, the soft solder will last for a long time.

What about pointers for the front panel? I use 6/32" X 1/2" pan head machine screws. Spray the heads of the screws with black paint. When dry, rub (fill) the slot with white lacquer stick. Wipe off excess with a dry rag. If you do not have a lacquer stick, white toothpaste will makes a passable substitute.

Once your preamp stages are complete and checked for operation you are ready to proceed to the detector. If you are of an optimistic nature, forget the check out and assume you wired it perfectly and everything is going to work as planned. My advice? Check the darn thing out. We all make mistakes.

If you have not previously done so, now is the time to push the chassis aside and do a little metal fabricating. Refer to Electric Radio Magazine, November 2000, Page 20. You can build this gadget almost as quickly as I can explain it. If you simply do not wish to put out the effort, leave the dial cord bit off. Use a direct shaft to insulating block that supports the antenna coil. It will work almost as well, though be much more difficult to adjust. To cover bands from 15 down through 40 I would recommend two turns of #12 or #14 wire

for the antenna coil. One turn may sometimes work better with certain antennas. However, after using both one turn and two turn coils on more than a dozen different receivers, I have found that two turns work better in most cases.

While we are discussing this coil, here is a good time to impress upon you that loose coupling is a very good thing with regens. Do not be surprised when you find that for best reception your antenna coil is often 1" or more above the grid coil.

After completing the link coupler, assemble a shock mount for the 6C4. I prefer heavy, copper clad epoxy board for the mount. Unfortunately, not many of you will have it available. I used my last scrap recently, and have no idea where to find more. So lets use a scrap of .062 or thicker aluminum. Cut it into a square approximately 2 3/4" per side. In each of the four corners drill a hole large enough to accommodate a medium sized rubber grommet. In the exact center drill a hole for a seven-pin tube socket. Use a socket with a spring loaded shield. I have included a drawing as well as a photograph of the mount.

Now you are ready to mount all parts. Follow the old carpenters rule, "measure twice-saw once." Care in layout is very important. I try to arrange my detectors in such a manner that lead length can be kept to a minimum.

Before you begin wiring, I would suggest that you solder up your connecting cable and wind your 20-meter coil. Why? Because it is human nature when you complete a radio to want to see if it works, and how well it works. If you wait until the chassis is completely wired before winding a coil, you are more apt to be in a hurry and goof-up in your coil winding.

Here is the coil winding data in a nutshell. Look at your antenna coil on the variable link gadget you built earlier. The top of this coil goes to ground, the bottom to the antenna. Now, note which way the coil is wound as it goes downward. Is it clockwise or counter-clockwise? It is imperative that the grid coil be wound in the same direction. If you can't remember, mark the coil form with an arrow pointing in the proper direction. You will probably want three coils total. The so-called 20-meter coil covers other bands as well but 20-meters will tune when the band-set capacitor is about half open. Think of the coil as being upside down. Normally when using a standard plug-in coil the antenna winding is on the bottom.

I wind all my coils with #20 or #22 solid, tinned, copper wire. It is available from Radio Shack, or almost any mail order supplier. I space my turns. Why? They look good, they are easy to 'dope,' and there is less chance for a shorted turn. The big advantage comes when changes, or 'tweaking' is required. 'Tweaking,' (adding or removing turns, or moving the tap) is also much easier. Do they work better when wide spaced? I never noticed much difference. Some writers like to use insulated wire and close space the windings. Fine, if you want to do it that way. However, you will find it is a lot more work, and there is more chance for error. Also remember that this coil is upside down and the bottom of the grid winding must be very near the TOP of your coil form.

I can hear readers saying, "You mention 'tweaking,' what are the chances that no tweaking will be required on my coils if I follow your directions?"

Hummmm. I would estimate that your chances are almost zero that some 'tweaking' will not be required. It is no big deal. You may want to move the frequency up or down a little or perhaps increase or decrease the feedback.

I promised coil data...here it is: 20-meters... 8-turns, tapped down from the top 1 1/2 to 2 turns, 40-meters... 16-turns, tapped at 2 to 3-turns, 80-meters... 34-turns tapped at approximately 4-

continued on next page

turns. I prefer common Radio Service Cement to hold the turns in place on the coil. I've also used a coat or two of varnish to coils with no apparent decrease in efficiency. It is difficult to give the exact number of turns for your tap. Every set is slightly different. If the set is reluctant to go into regeneration, add turns. If it goes into regeneration with a loud 'plop' or 'thump' move the tap down slightly. The 6C4 is such an easy tube to get into regeneration that it takes fewer turns on the tap than most other sets I've built. I would say this- the set will probably take less turns on the tap than you expect.

In radio's early years there was a lot of discussion-most of it bordering on superstition-about grid leaks. My advice is to use a resistor of 3.5 to 5 Megohms, and capacitor about 50 pf. Will a 100-pF work? Sure. Same for a 25 pf. There is really nothing to be overly concerned about. The grid leak is not all that critical.

You mentioned attenuating the signal for contest weekends. Yes, regens are very sensitive and do overload when the big guns turn loose. On some receivers I use a .01 from the antenna to ground to knock out about half the signal. Other sets I omit this feature and just rotate the antenna coil farther above the grid coil. My circuit for attenuation of signals is still under change from week to week.

OK, you have wired the set and it works. How do you know it is operating as it should? This is an excellent question. How do you measure a length of material without a yardstick or ruler?

Well, actually you cannot. However, here are some tips you may find useful. Assuming you have calibrated your receiver-and this should be your first step after completion-compare the number of signals received on a section of any band. I use the lower 50 KHz of twenty meters. The number should be near the same.

Listen to the audio. It should be clean, and with fidelity as good or better than any transceiver on the market. Try the regeneration (throttle capacitor) control. The set should slide into and out of regeneration very smoothly. You should be able to tune the entire band in question without resetting the regeneration control. You will find that the best operation is when the antenna coil is well away from the grid winding. If the antenna coil is down around the grid coil for proper operation, something is not right. Of course the set should show no excessive heat if left on indefinitely.

Measure drift. Zero beat the signal from the regenerative into your transceiver. Note the transceiver frequency. Now, go take a break and return one hour later. Chances are, you will not hear your zero beat signal. Slowly adjust the transceiver up or down until you pickup your regen. Zero beat the signals and note the frequency. The drift for your regen should not exceed 2 KHz for one hour. My bet is that it will be much less.

I can't think of many more 'pearls of wisdom' to bestow upon your tired ears. If you do indeed build the receiver and have a problem, I am as near as your computer. I will be glad to help you through any difficult times you might have. ER

Addendum: There is a lot of latitude in parts used in this radio. For example, the capacitors used in the cathode circuit of the 6SQ7's. Any capacity from 2 to 20 mfd will work OK. The voltage rating of C- can be anything as long as it is above 25 volts. I urge you to keep your detector voltage around 12 to 16 volts. Other voltages are not so critical. All e-mail questions about parts substitution, or other construction details will be answered promptly.

One more item: Take a look at the front panel of the receiver. Note the 'silver' skirted knobs on the bandset capacitor and link adjustment. I came into possession of some nice metal-skirted knobs for 3/8" shafts. I realize that there is an insert that will reduce these to a

standard 1/4" shaft-but I do not have any and have no idea where to find them. I removed the knobs from the metal skirt and attached the skirt to the panel with Radio Service Cement. Then, I fished around in my junk box and came up with two nice big pointer knobs. I do like the effect better than the original.

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813 Transmitter from page 27

with the input AC commercial power. In this system 120 AC was used based on the primary requirement for plate transformer. The input cable, #12 stranded, contains three wires; white, black, and green. The green always is bonded solidly to the chassis. The white is the neutral and the black is the "hot" side. All switching and fusing must be done in the black line. Two very large terminal strips were mounted inside each cabinet. To insure a low ohmic path scrape away all the paint under the metal end mounts. Using #14 bus wire, bond these terminals to the cabinet. All decks were provided with a rear chassis barrier strip bonded to the chassis and a wire installed between each deck and the cabinet terminal strip. Even the few pieces of commercial audio gear were grounded after removing the surface paint under the grounding lug. Special audio single point grounding in the speech amp will be addressed later.

My methods of obtaining parts has been discussed but don't forget the local stores in your area. You will be amazed what you will find in the plumbing and electrical department of your Home Depot or similar store. Items such as copper plated soft steel strapping and heavy copper wire for use in the PA, sheet and angle aluminum for shielding, and the nut and bolt hardware. Also Arts and Craft stores for dial pointers. Actually these were clock hands modified to fit the 6:1 Jackson drives. Electronic Parts stores for solder terminal strips, barrier strips, XLR mic connectors, lamps, fuse holders and fuses.

In the follow up article the construction of the various decks will be discussed including: the main Control unit, the 2000 volt HV supply, the triode connected push pull 813 Class B modulator, the speech amp with phase inverter and driver using a pair of triode connected push pull 807s in a cathode follower configuration, and the parallel connected 813 power amplifier.

Many thanks to all my 40 meter AM ham friends who contributed in many ways in support of this effort. Some had only encouragement to offer and that was surely appreciated for there were times when I was ready to dropped the entire project. A very special thanks is extended to Mike, WN3B for his continuous technical support, the many hour long twisted pair QSOs, and reading all the daily status reports and keeping me from straying too far off course. Mike is one of those many hams who has been down this road and has valuable experience and incite to offer.

Maybe your interest in home brewing has been sparked and you will enjoy reading the follow up article. As for total cost it would be less than $400. As for design-build elapsed time it was just about three months - retirement does have its benefits! Remember the freedom of home brewing is very rewarding and satisfying. It is a real part of the hobby. Especially if the project includes vacuum tubes with their warm glowing filaments and the clack of big contractors letting current flow into those wonderful humming pieces of iron. Try it. I guarantee you will like it. ER

Part 2 next month.

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